

WHAT IS CLAIMED IS:

1 1. A method for performing a fractional shift of transformed data,
2 comprising:
3 providing at least one fractional shift transform matrix in non-volatile storage
4 that is capable of fractionally shifting data by a shift factor;
5 receiving the transformed data; and
6 applying the at least one fractional shift transform matrix to the transformed
7 data to generate output transformed data that is fractionally shifted by the shift factor
8 without inverse transforming the transformed data.

1 2. The method of claim 1, wherein the transformed data comprises image
2 data.

1 3. The method of claim 1, wherein the transformed data includes data
2 that has been downsampled.

1 4. The method of claim 1, wherein the shift factor is between zero and
2 one.

1 5. The method of claim 1, wherein the non-volatile storage includes
2 matrices having different shift factors to perform the fractional pel shift at different
3 shift factors.

1 6. The method of claim 1, wherein the transformed data is transformed
2 by applying a Forward Discrete Cosine Transform (FDCT) to an input data stream.

1 7. The method of claim 6, wherein the input data stream was encoded
2 performing entropy encoding after applying the FDCT and quantization.

1 8. The method of claim 7, further comprising:

- 2 entropy decoding the received encoded data before applying the at least one
- 3 fractional shift transform matrix; and
- 4 entropy encoding the output fractionally shifted transformed data.

1 9. The method of claim 8, wherein the at least one fractional shift
2 transform matrix comprises three transformed matrices \tilde{A} , \tilde{B} , and \tilde{C} that are applied
3 to vectors $\tilde{G}_1, \tilde{G}_2, \dots, \tilde{G}_m$ from the entropy decoded encoded data, wherein the output
4 encoded data is generated using two functions comprising:

$$5 \quad \tilde{H}_k = \tilde{A} \bullet \tilde{G}_k + \tilde{B} \bullet \tilde{G}_{k+1} \quad \text{for } k = 1, 2, \dots, m-1$$

$$6 \quad \tilde{H}_k = \tilde{C} \bullet \tilde{G}_k \quad \text{for } k = m,$$

7 wherein the output encoded data comprises an $m \times m$ matrix of the vectors $\tilde{H}_1,$
8 $\tilde{H}_2, \dots, \tilde{H}_m.$

1 10. The method of claim 8, wherein the fractional shift is collocated on a
2 first data point in the encoded data to fractionally shift the data.

1 11. The method of claim 9, wherein the transform matrices \tilde{A} , \tilde{B} , and \tilde{C}
2 are modified to accomplish dequantization and requantization of the vectors \tilde{G}_1 ,
3 $\tilde{G}_2, \dots, \tilde{G}_m$ and $\tilde{H}_1, \tilde{H}_2, \dots, \tilde{H}_m$, respectively.

1 12. The method of claim 1, wherein each fractional shift transform matrix
2 is generated by applying a two-dimensional Forward Discrete Cosine Transform
3 (FDCT) to a fractional shift matrix including the shift factors.

1 13. The method of claim 1, wherein the received and output encoded data
2 is encoded using one of the Joint Photographic Experts Group (JPEG) or Moving
3 Pictures Expert Group (MPEG) compression techniques.

1 14. The method of claim 1, wherein the steps of providing the at least one
2 transformed matrix, receiving the input data stream, and applying the at least one
3 transformed matrix are performed by a printer.

1 15. The method of claim 1, further comprising:
2 decoding the output encoded data; and
3 rendering the decoded data on an output device.

1 16. The method of claim 15, wherein the output devices is a member of a
2 set of output devices comprising a printer, display monitor, and storage.

1 17. The method of claim 1, wherein the fractional shift matrix is modified
2 to accomplish dequantization and requantization of the transformed data without
3 inverse transforming the transformed data.

1 18. A system for performing a fractional shift of transformed data,
2 comprising:
3 a non-volatile storage;
4 at least one fractional shift transform matrix represented in the non-volatile
5 storage that is capable of fractionally shifting data by a shift factor;
6 means for receiving the transformed data;
7 means for applying the at least one fractional shift transform matrix to the
8 transformed data to generate output transformed data that is fractionally shifted by the
9 shift factor without inverse transforming the transformed data.

1 19. The system of claim 18, wherein the transformed data comprises
2 image data.

1 20. The system of claim 18, wherein the transformed data includes data
2 that has been downsampled.

1 21. The system of claim 18, wherein the shift factor is between zero and
2 one.

1 22. The system of claim 18, wherein the non-volatile storage includes
2 matrices having different shift factors to perform the fractional pel shift at different
3 shift factors.

1 23. The system of claim 18, wherein the transformed data is transformed
2 by applying a Forward Discrete Cosine Transform (FDCT) to an input data stream.

1 24. The system of claim 23, wherein the input data stream was encoded
2 performing entropy encoding after applying the FDCT and quantization.

1 25. The system of claim 24, further comprising:
2 means for entropy decoding the received encoded data before applying the at
3 least one fractional shift transform matrix; and
4 means for entropy encoding the output fractionally shifted transformed data.

1 26. The system of claim 18, wherein each fractional shift transform matrix
2 is generated by applying a two-dimensional Forward Discrete Cosine Transform
3 (FDCT) to a fractional shift matrix including the shift factors.

1 27. The system of claim 18, wherein the steps of providing the at least one
2 transformed matrix, receiving the input data stream, and applying the at least one
3 transformed matrix are performed by a printer.

1 28. The system of claim 18, further comprising:
2 decoding the output encoded data; and
3 rendering the decoded data on an output device.

1 29. The system of claim 28, wherein the output devices is a member of a
2 set of output devices comprising a printer, display monitor, and storage.

1 30. The system of claim 18, wherein the fractional shift matrix is modified
2 to accomplish dequantization and requantization of the transformed data without
3 inverse transforming the transformed data.

1 31. An article of manufacture including code for performing a fractional
2 shift of transformed data, wherein the code causes operations to be performed, the
3 operations comprising:
4 providing at least one fractional shift transform matrix in non-volatile storage
5 that is capable of fractionally shifting data by a shift factor;
6 receiving the transformed data; and
7 applying the at least one fractional shift transform matrix to the transformed
8 data to generate output transformed data that is fractionally shifted by the shift factor
9 without inverse transforming the transformed data.

1 32. The article of manufacture of claim 31, wherein the transformed data
2 comprises image data.

1 33. The article of manufacture of claim 31, wherein the transformed data
2 includes data that has been downsampled.

1 34. The article of manufacture of claim 31, wherein the shift factor is
2 between zero and one.

1 35. The article of manufacture of claim 31, wherein the non-volatile
2 storage includes matrices having different shift factors to perform the fractional pel
3 shift at different shift factors.

1 36. The article of manufacture of claim 31, wherein the transformed data
2 is transformed by applying a Forward Discrete Cosine Transform (FDCT) to an input
3 data stream.

1 37. The article of manufacture of claim 36, wherein the input data stream
2 was encoded performing entropy encoding after applying the FDCT and
3 quantization.

1 38. The article of manufacture of claim 37, further comprising:
2 entropy decoding the received encoded data before applying the at least one
3 fractional shift transform matrix; and
4 entropy encoding the output fractionally shifted transformed data.

1 39. The article of manufacture of claim 38, wherein the at least one
2 fractional shift transform matrix comprises three transformed matrices \tilde{A} , \tilde{B} , and \tilde{C}
3 that are applied to vectors $\tilde{G}_1, \tilde{G}_2, \dots, \tilde{G}_m$ from the entropy decoded encoded data,
4 wherein the output encoded data is generated using two functions comprising:

5 $\tilde{H}_k = \tilde{A} \bullet \tilde{G}_k + \tilde{B} \bullet \tilde{G}_{k+1}$ for $k = 1, 2, \dots, m-1$

6 $\tilde{H}_k = \tilde{C} \bullet \tilde{G}_k$ for $k = m$,

7 wherein the output encoded data comprises an mxm matrix of the vectors \tilde{H}_1 ,

8 $\tilde{H}_2, \dots, \tilde{H}_m$.

1 40. The article of manufacture of claim 38, wherein the fractional shift is
2 collocated on a first data point in the encoded data to fractionally shift the data.

1 41. The article of manufacture of claim 39, wherein the transform
2 matrices \tilde{A} , \tilde{B} , and \tilde{C} are modified to accomplish dequantization and requantization
3 of the vectors $\tilde{G}_1, \tilde{G}_2, \dots, \tilde{G}_m$ and $\tilde{H}_1, \tilde{H}_2, \dots, \tilde{H}_m$, respectively.

1 42. The article of manufacture of claim 31, wherein each fractional shift
2 transform matrix is generated by applying a two-dimensional Forward Discrete
3 Cosine Transform (FDCT) to a fractional shift matrix including the shift factors.

1 43. The article of manufacture of claim 31, wherein the received and
2 output encoded data is encoded using one of the Joint Photographic Experts Group
3 (JPEG) or Moving Pictures Expert Group (MPEG) compression techniques.

1 44. The article of manufacture of claim 31, wherein the steps of providing
2 the at least one transformed matrix, receiving the input data stream, and applying the
3 at least one transformed matrix are performed by a printer.

1 45. The article of manufacture of claim 31, further comprising:
2 decoding the output encoded data; and
3 rendering the decoded data on an output device.

1 46. The article of manufacture of claim 45, wherein the output devices is
2 a member of a set of output devices comprising a printer, display monitor, and
3 storage.

1 47. The article of manufacture of claim 31, wherein the fractional shift
2 matrix is modified to accomplish dequantization and requantization of the
3 transformed data without inverse transforming the transformed data.